

**Effects of Feeding Glycerol with Different  
Levels of Non-Fiber Carbohydrates**

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# **Effects of Feeding Glycerol with Different Levels of Non-Fiber Carbohydrates**

## **Introduction**

As a result of increased biofuel production in recent years, there has been a surge of new byproducts. Biofuel companies are eager to find new and marketable uses for these components. One such derivative is glycerol, a byproduct of soy biodiesel. Glycerol, as a chemical compound that serves as the framework for triglycerides, is just a few metabolic steps away from glucose, a major energy source for living plants and animals (Ouellette, 1997). In ruminants, the glycerol can be converted to propionate in the rumen, the propionate can be absorbed across the ruminal wall, and then the propionate can be converted to glucose in the liver. This attribute of glycerol makes it attractive for producers searching for less expensive alternatives to corn. Also for small batch processors of biodiesel, using crude glycerol as a feed ingredient would negate the need to dispose of it as waste.

Previous research with providing glycerol to dairy cattle has investigated its use for prevention and treatment of ketosis (Goff and Horst, 2001; Ogborn et al., 2004). In one study, (DeFrain et al., 2004), glycerol was fed at 3% of the cow's dry matter (DM) intake with a fibrous carbohydrate (NFC) level of 40%. Further research is needed to determine whether a different level of NFC or glycerol would better enhance the positive effects of feeding glycerol. Previous studies utilizing the 40% NFC did not exhibit the level of positive outcome expected by such a compound so chemically close to glucose (DeFrain et al., 2004).

This study will more closely examine the effect of different concentrations of glycerol and NFC on animal performance when fed as a total mixed ration (TMR) formulated for dairy cattle. The research was conducted to determine optimal dietary concentrations of glycerol and NFC for the utilization of this biodiesel byproduct in the TMR for dairy cattle. This research should be beneficial to dairy producers searching for cost-effective energy sources, but it also will benefit the biofuel industries nationwide.

## **Objectives**

The objective of this research was to determine the optimum concentrations of dietary glycerol and NFC on the DM intake (DMI), milk yield, and milk composition of dairy cattle. Our hypothesis was that feeding up to 10% glycerol with 37% NFC would result in similar animal performance to feeding 0 or 5% glycerol, but feeding 10% glycerol with 42% NFC would result in lower DM intake, milk yield, and milk fat percentage.

## **Location, Facilities, and Equipment**

Research was primarily conducted at the Waterman Agricultural Laboratory, specifically, the Waterman Dairy Facility in Columbus, Ohio. Faculty supervision was provided by Dr. Maurice Eastridge (Department of Animal Sciences, 2029 Fyffe Court, 221B Animal Science Building, Columbus, OH 43210, (614) 688-3059, [eastridge.1@osu.edu](mailto:eastridge.1@osu.edu)). University laboratories will be utilized for further sample analyses.

## **Materials and Methods**

Forty-eight multiparous cows [ $112 \pm 33$  days in milk (DIM)] were blocked into groups of four by lactation number, DIM, and milk yield. Cows within a block were randomly assigned to one of four dietary treatments. The diets contained about 9.1% alfalfa hay, 37.4% corn silage, and 53.5% concentrate (Table 1). The four dietary treatments were: 1) control diet with 0% glycerol and 37% NFC, 2) 5% glycerol and 37% NFC, 3) 10% glycerol and 37% NFC, and 4) 10% glycerol and 42% NFC. All cows were fed the control diet for 5 days for covariate adjustment of DM intake and milk yield. The four experimental diets were fed for 8 weeks. Diets were mixed once daily but divided into 2 feedings per day. Feed intake and milk yield were recorded daily. Milk was sampled for 2 consecutive days during each week of the experimental period for analysis of milk composition by the Ohio DHI Cooperative (Columbus, OH). Body weight was recorded weekly, and body condition scores were recorded at the beginning of the trial and every four weeks thereafter. Samples of corn silage were dried weekly for adjustment of the TMR as needed.

## **Discussion**

The DMI was similar among the diets (Table 2). Therefore, feeding up to 10% glycerol, even at the higher concentration of NFC at 42%, did not have a negative impact on DMI. Actually, DMI was about 2 kg/d higher with 10% glycerol and 42% NFC than for the control diet. These observations for DMI with feeding glycerol may be due to the sweet-tasting nature of glycerol, and the glycerol in the TMR helped to hold the ingredients within the mixture to reduce the risk of sorting. The yields of milk and 4% fat-correct milk (FCM) also were similar among the treatments. Given that DMI and milk yield were similar among diets and the feeding period was 8 weeks in length, it is not surprising that BCS was similar among the cows fed the different diets. With cows averaging 112 DIM, the BCS of 2.8 was as expected for the respective DIM. The feed efficiency (FCM/DMI) of 1.4 to 1.5 was as expected for the average DIM; however, feed efficiency was lowest for the cows fed 10% glycerol with 42% NFC, primarily because of the slightly higher DMI with a concomitant lower FCM yield. Feed efficiency was highest for control and intermediate for the 2 diets with glycerol and 37% NFC.

Feeding glycerol resulted in reduced milk fat percentage and yield, especially for the diet with 42% NFC. A 0.3 percentage unit drop in milk fat for the diets with glycerol and 37% NFC and a 0.6 percentage unit drop with 10% glycerol and 42% NFC compared to control certainly reflect some alterations in animal metabolism. The milk fat depression was likely due to

differences in metabolism of glycerol as opposed to starch from corn. Milk fat depression was not likely related to ruminal acidosis as DMI was sustained, and DMI even numerically increased with inclusion of glycerol. It is important to regard glycerol as a highly fermentable carbohydrate and to avoid its inclusion with high concentrations of NFC. Milk protein and milk urea nitrogen were neither affected by glycerol nor NFC concentrations.

Based on the DMI, milk yield, and milk composition for each treatment and assuming glycerol at \$0.22/kg and using current feed prices, the income over feed costs (IOFC; \$/day) were 9.89, 9.73, 10.00, and 9.58, respectively. The lowest IOFC occurred for the 10% glycerol and 42% NFC because of the higher DM intake and lower milk fat yield.

**Table 1: Ingredient composition of experimental diets.<sup>1</sup>**

<b>Ingredient<sup>2</sup></b>	<b>0-GLY/37-NFC</b>	<b>5-GLY/37-NFC</b>	<b>10-GLY/37-NFC</b>	<b>10-GLY/42/NFC</b>
Alfalfa hay	9.09	9.10	9.08	9.09
Corn silage	37.4	37.4	37.4	37.4
Corn, dry ground	14.2	6.73	0.00	7.87
SBM, 48% CP	11.4	12.9	13.3	14.42
Distillers' grain	10.8	10.8	11.3	10.8
Soybean hulls	14.9	15.8	16.8	8.15
Glycerol	0.00	4.98	9.93	9.94
Feed grade urea	0.298	0.259	0.219	0.258
Dicalcium phosphate	0.378	0.418	0.477	0.437
Limestone	0.795	0.756	0.695	0.855
Magnesium oxide	0.078	0.078	0.087	0.107
Potassium sulfate	0.117	0.117	0.117	0.117
TM salt	0.497	0.498	0.497	0.497
Vitamin A premix	0.016	0.016	0.016	0.016
Vitamin D premix	0.040	0.040	0.040	0.040
Vitamin E premix	0.060	0.060	0.060	0.060

<sup>1</sup>Dietary treatments: 0% Glycerol (GLY) and 37% nonfiber carbohydrates (NFC), 5% GLY and 37% NFC, 10% GLY and 37% NFC, and 10% GLY and 42% NFC.

<sup>2</sup>SBM = Soybean meal, CP = crude protein, and TM = trace mineralized.

**Table 2: Performance of cows fed experimental diets.<sup>1</sup>**

Item <sup>2</sup>	0-GLY/37-NFC	5-GLY/37-NFC	10-GLY/37-NFC	10-GLY/42-NFC	SE	P
DM intake, kg/d	22.8	23.7	24.3	24.9	0.8	0.20
BCS	2.78	2.83	2.82	2.80	0.03	0.78
Milk, kg/d	38.1	39.3	40.5	40.4	1.17	0.32
4% FCM, kg/d	36.0	33.6	35.8	33.5	2.2	0.39
FCM/DMI, kg/kg	1.53 <sup>a</sup>	1.41 <sup>bc</sup>	1.50 <sup>ac</sup>	1.39 <sup>b</sup>	0.06	0.01
Milk fat, %	3.52 <sup>a</sup>	3.18 <sup>b</sup>	3.19 <sup>b</sup>	2.93 <sup>b</sup>	0.12	0.01
Milk fat, g/d	1357 <sup>d</sup>	1212 <sup>efg</sup>	1298 <sup>dg</sup>	1158 <sup>e</sup>	82	0.08
Milk protein, %	3.10	3.04	3.04	3.07	0.05	0.77
Milk protein, g/d	1194	1162	1226	1230	68	0.69
MUN, mg/dl	14.5	14.4	14.1	14.3	0.4	0.84

<sup>1</sup>Dietary treatments: 0% Glycerol (GLY) and 37% nonfiber carbohydrates (NFC), 5% GLY and 37% NFC, 10% GLY and 37% NFC, and 10% GLY and 42% NFC.

<sup>2</sup>DM = Dry matter, BCS = body condition score (1 = thin, 5 = fat), FCM = 4% fat-corrected milk, DMI = dry matter intake, and MUN = milk urea nitrogen.

<sup>abc</sup>Means in the same row with different superscripts differ ( $P < 0.05$ ).

<sup>defg</sup>Means in the same row with different superscripts differ ( $P < 0.10$ ).

## Conclusion

Glycerol is valuable as a feed ingredient for lactating dairy cattle. It has the ability to sustain high levels of milk production while potentially increasing IOFC. Glycerol is a highly fermentable carbohydrate and should not be utilized in diets with high concentrations of NFC.

## Literature Cited

- DeFrain, J.M., A.R. Hippen, K.F. Kalscheur, and P.W. Jardon. 2004. Feeding glycerol to transition dairy cows: Effects on blood metabolites and lactation performance. *Journal of Dairy Science* 87: 4195-4206.
- Goff, J.P., and R.L. Horst. 2001. Oral glycerol as an aid in the treatment of ketosis/fatty liver complex. *Journal of Dairy Science* 84:635. (Abstr.)
- Ogborn, K.L., R. Paratte, K.L. Smith, P.W. Jardon, and T.R. Overton. 2004. Effects of method of delivery of glycerol on performance of dairy cows during the transition period. *Journal of Dairy Science* 87:440. (Abstr.)
- Ouellette, R.J. 1997. Introduction to General, Organic, and Biological Chemistry, Fourth Edition.